Motient suggests that the level of interference caused by terrestrial operations is not significant because Motient claims that it is within the range of interference that any satellite system is allowed to cause, as a matter of right, under ITU rules.[27] Motient essentially claims that as long as its replacement satellite system, and its new terrestrial components, do not create more than a defined percentage of additional "noise," the United States has no further ITU obligations to be concerned about. This argument is fundamentally flawed because the ITU parameter to which Motient refers is wholly inapposite in a situation where interference will be caused by a terrestrial service. The "6% $\Delta T/T$" value to which Motient refers expressly applies only to coordination of geostationary satellite networks with each other.[28] Thus, there is no basis in the Radio Regulations for contending that Motient's proposed terrestrial service, or any other terrestrial service in derogation of the ITU Table, may permissibly cause some threshold level of interference into Inmarsat's geostationary network. Moreover, neither Inmarsat nor the UK has any obligation to coordinate its MSS system with any terrestrial services that Motient desires to provide. To the contrary, the United States is clearly obligated not to authorize any terrestrial service at L-Band that would cause interference to Inmarsat or any other international MSS system using the L-Band. Even if an MSS system were willing to take terrestrial interference into account in a coordination, the attached Technical Annex demonstrates that Motient has grossly overestimated the "margin" that would be available to such MSS systems to accommodate new interference sources from terrestrial systems using the L-Band.[29]

The Commission's own precedent for licensing secondary services is consistent with these reasons not to license terrestrial uses of the L-Band. As the Commission has

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27 *See Motient Ex Parte Presentation* at 2-4, File No. SAT-ASG-20010302-00017, et al. (filed July 6, 2001)

28 *See* ITU Radio Regulations, Article S9, Sections 9.6, 9.7 & 9.27; Appendix S5 & Table S5-1.

29 *See* Technical Annex at Sections 3.1 & 4.6.

acknowledged in a variety of contexts, it simply is illogical to license an applicant -- even on a non-interference basis -- unless there is a reasoned basis to conclude that the applicant would be able to provide service without interfering with others.[30] Here, there is no such basis.

Nor would it provide an effective enforcement means to condition a license to operate on a secondary basis on the requirement that the terrestrial service "shut down" upon notice of interference. The Inmarsat spacecraft would receive two types of signals emitted from the Motient system: signals transmitted from Motient handsets to the Motient satellite (which should be within the scope of the coordination), and signals transmitted from Motient handsets to the Motient terrestrial base stations (which would be outside the scope of the coordination). Both types of signals would be transmitted in the same frequency bands, and would combine to produce an aggregate source of interference into the Inmarsat system. There would be no practical way to identify in outer space the individual components of this aggregate interference, and therefore no practical way to monitor (or identify) the level of interference caused by the terrestrial components of the Motient system. The Commission is doubtlessly aware of the practical difficulties of regulating aggregate transmissions from the Earth's surface in order to protect satellite receive beams.[31]

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30 *See, e.g.*, 47 C.F.R. § 74.703(a) (requiring that "any application for a new low power TV, TV translator, or TV booster station ... will not be granted when it is apparent that interference will be caused."); In re Newcomb Communications, Inc. for Modification of its Interim Authority in the 1610-1626.5 MHz Frequency Band to Add an Outbound Link in the 3700-4200 MHz Frequency Band, *Order and Authorization*, 11 FCC Rcd 3084 (1996) (granting a waiver, in part, upon showing that NewComb's proposed use would not create increased interference); Geostar Positioning Corporation, 4 FCC Rcd 4538 (1989) (concluding that the public interest would be served by allowing certain frequencies to be used to provide FSS, upon showing that the transmissions are not likely to cause harmful interference into authorized services); *see also* Mobile Datacom Corporation, 10 FCC Rcd 4552 (1995) (granting authorization to operate on a temporary basis in view of documented lack of interference).

31 *See, e.g., Report of the LMDS/FSS 28 GHz Negotiated Rulemaking Committee* at ii & 90 (September 23, 1994), CC Docket 92-297 (industry unable to develop regulations that

D. Terrestrial Services Violate Commission Conditions On The Use Of The L-Band

The Commission has noted a number of times that, in the absence of an annual coordination agreement among Motient, Inmarsat, and three other L-Band systems, each of those systems is required to provide service in the U.S. on a non-interference basis to the other systems.[32] As set forth in the attached Technical Annex, terrestrial use of the L-Band would cause interference both into Inmarsat's satellite receivers, as well as into Inmarsat's mobile terminals within the U.S., on the ground, on the water, and in the air. Thus, under the Commission's own policies, the L-Band may not be used for terrestrial services.

III. CONSISTENT WITH INTERNATIONAL AGREEMENTS, THE COMMISSION SHOULD LIMIT THE USE OF THE L-BAND TO SATELLITE SERVICES

A. Grant Of Motient's Application Is Inconsistent With The Mexico City MOU

1. The Mexico City MOU

As the Commission has recognized, the international coordination of the L-Band for MSS uses has been difficult due to high demand for the limited amount of spectrum, and competition for that spectrum among a number of different MSS systems.[33] After seven years of negotiations, the United States, Inmarsat, Canada, Mexico and Russia entered into an agreement (and a periodic reassignment mechanism) that created a unique solution -- a flexible framework for the assignment of L-Band spectrum for MSS service to North America.[34]

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feasibly could be enforced in order to regulate aggregate interference into satellite receive beams caused by large numbers of terrestrial transmitters).

32 *See Inmarsat Authorization* at ¶ 67; *see also Satcom Systems, Inc. and TMI Communications and Co.*, 14 FCC Rcd 20798 at ¶ 33 (1999) ("*TMI Order*"), *aff'd, AMSC Subsidiary Corporation v.* FCC, 216 F.3d 1154 (D.C. Cir. 2000).

33 *TMI Order* at ¶ 8.

34 *See International Action: "FCC Hails Historic Agreement on International Satellite Coordination, News Release,"* Report No. IN 96-16 (June 25, 1996) (the "MOU" or "Mexico City MOU").

The MOU governs the use of spectrum by MSS spacecraft and provides for a dynamic reassignment of spectrum among users, based on demonstrated need to serve North America. Thus, systems like Inmarsat's that are growing are expected to be able to obtain access to more bandwidth, and those that are not using all of their assigned bandwidth (such as Motient and TMI Communications and Company, L.P. ("TMI")) are expected to make it available to others.

2. Motient Must Coordinate Its Proposed System And Terrestrial Use

The United States would violate its obligations under the MOU if it allowed Motient to provide ancillary terrestrial service in the L-band, or if it allowed other companies to provide terrestrial service at L-Band. This is true even if such service were restricted to those frequency assignments designated to Motient in the last annual coordination agreement in which Motient participated, as suggested in the *Flexibility NPRM.*[35]

Motient's terrestrial proposal is inconsistent with the MOU for at least the following reasons:

First, the MOU expressly obligates the United States to avoid situations, such as the one presented here, that could potentially give rise to unacceptable interference within North America into the MSS systems covered by the MOU.[36] As demonstrated above, the Motient proposal would cause unacceptable interference into Inmarsat's MSS operations, and other terrestrial uses could cause similar problems.

Second, the MOU obligates the United States to cause Motient to negotiate a new operating agreement every year.[37] The MOU is premised on the need to take into account different growth rates of the different MSS systems, and the desire to ensure that future MSS

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35 *See Flexibility NPRM* at ¶ 49.

36 *See MOU* at ¶ 16.

37 *Id.* at ¶ 11.

system growth is not compromised.[38] Motient claims that its current satellite system service is not viable and that "the only future for using satellites to bridge the digital divide and provide nationwide mobile service" involves adding in-band terrestrial facilities,[39] and that Motient *cannot afford to replace its existing satellite system* unless its is able to offer this new terrestrial service in order to provide service in urban markets.[40] In contrast, Inmarsat's system is successful and, as discussed above, needs to coordinate access to a greater portion of the L-Band spectrum. The MOU is very clear that the excess bandwidth assigned to any of the systems covered by the MOU should be reassigned to other systems covered by the MOU that have spectrum needs, and the United States has an obligation to ensure that this occurs.

Inmarsat urges the Commission to cause Motient to immediately resume coordination under the MOU. For the past three years, Motient has delayed and impeded the negotiation of an operating agreement, thus preventing the reassigning of spectrum among the parties. It is inconsistent with United States' obligations under the MOU for Motient to drag its feet and refuse to negotiate while it awaits Commission action on this terrestrial proposal in the hope that it can expand its spectrum claims with an additional and ancillary FCC authorization.

Third, as noted earlier, L-Band spectrum is not internationally allocated for terrestrial purposes over North America and the parties who negotiated the MOU never intended that it be used in such a manner. These terrestrial components would substantially increase Motient's usage in the band and preclude MSS systems from accessing the spectrum they need to operate.

Inmarsat therefore agrees with the Commission's proposal that "any additional spectrum requirements generated by the terrestrial services should not be a factor for

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38 *Id.* at ¶ 8(d); *see also id.* at ¶¶ 5 & 6.

39 *Motient Consolidated Opposition* at ii; *Application* at 10-12.

40 *Motient Consolidated Opposition* at 3.

consideration in the annual satellite coordination review."[41] Inmarsat entered the MOU with the understanding that the L-Band was to be reserved for satellite services only. It was on this assumption that Inmarsat agreed to the terms of the MOU, and it was on this assumption in part that Inmarsat has invested over $1.5 billion and intends to invest over $1.7 billion more in its MSS network.

Moreover, the MOU does not require the other parties to take into account the spectrum needs of Motient's newly proposed terrestrial services in the L-Band, and no party has the right to justify its spectrum needs based, in whole or in part, on any terrestrial services that it may desire to propose.[42] The Technical Annex demonstrates that Motient would need more L-Band spectrum to operate a network with a terrestrial component then a satellite-only network.[43] This is because the self-interference caused by Motient's terrestrial component would reduce the traffic-carrying capacity of Motient's satellite component. Thus, Motient either does not need as much spectrum for satellite services as it claims it needs (because its satellite capacity will be decreased) or Motient's spectrum needs really are based on its terrestrial plans. To allow Motient's proposed terrestrial-based use of the L-Band would impermissibly force Inmarsat and other potential MSS providers in the United States to bear the burden of Motient's attempt to convert the nature of its service from a satellite to terrestrial-based service.

Contrary to the suggestions of some,[44] Motient's ancillary terrestrial proposal should not be interpreted as an indication that too much spectrum has been designated for MSS use. Inmarsat's experience is that L-Band spectrum remains a scarce MSS resource that must be

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41 *Flexibility NPRM* at ¶ 49.

42 *See MOU* at ¶¶ 1, 2, 4-8 & 17.

43 Technical Annex at Section 3.5.

44 *See Flexibility NPRM* at ¶ 28.

preserved for MSS use, and the history behind the negotiation of the MOU supports this.[45] This scarcity problem is exacerbated by Motient's refusal, as part of the annual review process, to agree to reassign the spectrum that it does not need or use for its satellite operations.

Finally, the Commission correctly notes that there has not been agreement on a new operating agreement since 1998, but this should not lead to the conclusion that this is not a problem.[46] The reason the parties have been able to operate in the meantime without interfering with each other is that they have maintained the status quo by operating based on the annual operating agreement negotiated in 1998. As explained above, Inmarsat has been able to do so by maximizing the efficiency of its existing spectrum assignments, but increasing customer demands require that Inmarsat coordinate more spectrum to provide for the growth of its network. Inmarsat stands ready to do so under the terms of the MOU.

B. Motient Cannot Be Given Exclusive Use Of The L-Band

Motient's seeks a license to use the entire L-Band spectrum range for its terrestrial and satellite components.[47] However, as the Commission noted in the *Inmarsat Authorization*, Motient is not entitled to preclude other operators from using the L-Band under the pretext that its use of the whole band would be "subject to international coordination." Such a result would be contrary to the United States' obligations under the World Trade Organization Agreement on Basic Telecommunication Service.[48]

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45 *See TMI Order* at ¶ 8.

46 *See Flexibility NPRM at note 83* (noting that Motient, TMI and Inmarsat have been operating on an non-interference basis for the past two years without complaints regarding interference).

47 *Application* at 8-9, Exhibit A at 3.

48 *Inmarsat Authorization* at ¶ 67.

IV. THERE IS NO NEED FOR MOTIENT'S PROPOSED TERRESTRIAL SERVICE IN THE L-BAND

There is no significant public policy goal served by opening the L-Band to terrestrial use. Although Motient has proposed that its terrestrial components will serve as a "fill-in" service for urban areas and thereby support its rural service, there is no effective means by which the Commission could ensure that the supposedly "ancillary" terrestrial uses do not overtake the satellite uses of the L-Band.

The Commission has asked whether the proposed terrestrial services at L-Band would be truly ancillary to satellite service offerings.[49] The answer is "no" for a number of reasons. As an initial matter, Motient's terrestrial system appears to be designed to support far greater numbers of co-channel carriers, and far greater numbers of total users, than its satellite system. Motient attempts to downplay the significance of the terrestrial component of its proposed network by suggesting that it will cover only about 1% of the land mass of the United States.[50] This is belied by the fact that approximately 32 million people live in an area one-fifth this size -- the 0.18% of the U.S. that constitutes the area of the twenty-five most populous cities.[51]

Second, it is not a meaningful limitation to propose that the terrestrial network would only be used if the satellite path were "blocked."[52] This is, by definition, an unenforceably vague standard for determining when terrestrial use would be permitted, and there would be no way to monitor compliance in any event. As a business and engineering matter, where a handset is within range of a terrestrial base station and has a "choice" between

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49 *See Flexibility NPRM* at ¶ 41.

50 *Application* at 13, Appendix A at 25.

51 *See* U.S. Census Bureau, *Statistical Abstract of the United States, The National Data Book* at 7, 39-41 (120th Ed. 2000) (1998 data).

52 *Application* at ii.

communicating with a satellite or a terrestrial base station, the terrestrial link will be used.[53] It strains credibility for Motient to claim that the satellite will always be first choice for the handset. This simply does not make sense if Motient plans to compete with terrestrial operators on a quality of service or cost basis.

If the Motient proposal were approved, Motient's service, with potentially millions of handsets concentrated in urban and suburban areas, would likely evolve into yet another nationwide terrestrial mobile phone company. With six terrestrial nationwide mobile phone providers in the U.S., there is no reason to think that, as the seventh competitor in this area, Motient will be able to fare any better than it did as an MSS provider. But, as explained above, such a broad terrestrial L-Band system would have a significant and adverse effect on Inmarsat's system, and on Inmarsat's ability to use the limited L-Band.

As the Commission notes in the *Flexibility NPRM*, there are alternative arrangements that Motient can enter into with CMRS providers to create a more robust service, and to provide in-building service and coverage of areas where MSS signals may be blocked by buildings or terrain.[54] To the extent that Motient believes that its MSS system will not be able to operate in urban areas, there is a practical solution that exists -- without the problems created by using the L-Band for terrestrial purposes -- and that is dual-band phones. These phones already exist today and are being used by companies such as Globalstar, ACes and Thuraya to allow satellite bands to be used when the phone is beyond the reach of the terrestrial network, and terrestrial bands to be used when the phone is within reach. These dual-band phones are no more expensive or bulky than Motient's dual-mode phone (with terrestrial and satellite modes operating in the same frequency) would be, and provide a high level of functionality. Motient

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53 *See* Technical Annex at Section 5.2.

54 *See Flexibility NPRM* at ¶ 27.

itself has experience in this area from its communication service already provided through a satellite and terrestrial dual band network.[55]

Motient previously has responded to this suggestion by asserting "[t]he experience of Iridium and Globalstar demonstrate that resale of another carrier's terrestrial service is a fatal strategy for a satellite system."[56] That is absurd. By all accounts, the Iridium and Globalstar problems arose from a combination of the following factors: (i) getting to the market far too late and well after cellular and PCS coverage had extended to most of the populated areas of the world, (ii) charging too much for service (and phones) that were directly competitive with cellular and PCS service, (iii) ineffective global partnerships and distribution mechanisms, (iv) capital structures and debt obligations that constrained the flexibility to respond to unforeseen problems in the market, (v) billions and billions of dollars of capital invested in spacecraft that could not support data rates demanded by the market and that had useful lives far shorter than GSO spacecraft, and (vi) handheld terminals that were too big (the size of obsolete cell phones) and therefore unappealing. In other words, these systems suffered from debilitating problems regardless of any attempt they may have made resell terrestrial services, not because of any attempt to operate with a dual band capability. Likewise, adding a terrestrial component to Motient's system will not insulate Motient's satellite business from these same types of business problems.

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55 *See* Motient *Form 10-K for the fiscal year ended December 31, 2000* at Item 1 ("We offer our customers the nation's largest, most fully-deployed terrestrial wireless two-way data network, comprising over 2,000 base stations that provide service to 430 of the nation's largest cities and towns, including virtually all metropolitan areas. In 2000, we significantly improved terrestrial network performance and coverage, adding approximately 200 new base stations. Our satellite in geosynchronous orbit overlays our terrestrial network, thereby extending the service area coverage of our network for certain of our transportation service offerings throughout all 50 states and the Caribbean. The satellite also provides nationwide voice and dispatch services.")

56 *Motient Consolidated Opposition* at 10, note 16.

In the end, while Motient may not be in a position to fully use the L-Band for its intended purpose, Inmarsat is ready, willing and able to do so. Inmarsat currently is capable of providing voice and data services of up to 64 kbps throughout the U.S. and, in the next few years, the speed of this service will increase to 432 kbps. Having received authorization to operate in the United States, Inmarsat is now poised to help bridge the Digital Divide through its satellite-based service.

In sum, considering the alternative methods of providing mobile phone service in America and the significant interference threat to Inmarsat's network, the harm from allowing terrestrial use of even a portion of the L-Band far outweighs any limited benefit that might be derived.

V. CONCLUSION

The Commission should not allow terrestrial use of the L-Band for four main reasons: (i) terrestrial uses would create unacceptable inference into Inmarsat's MSS satellite network, including vital safety services provided in the L-Band, and nearby frequencies; (ii) terrestrial uses would violate the United States' treaty obligations under the ITU Radio Regulations, and under a separate international L-band coordination agreement that governs use of the L-Band over North America, to which the United States is a party; (iii) such terrestrial uses would exacerbate existing spectrum scarcity problems in the L-Band; and (iv) Motient's desire to serve the areas where its satellite signals are weak can be met by using dual-band phones that operate in terrestrial frequencies without raising these interference, legal and policy impediments.

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Technical Annex

1 Introduction

This Technical Annex addresses the technical issues raised in the Commission's "Flexibility" NPRM concerning the Motient proposal to introduce a terrestrial system into the parts of the upper and lower L band currently used by MSS satellite systems, such as Inmarsat's.[1]

Inmarsat's analysis demonstrates that the Motient terrestrial proposal would cause interference to Inmarsat and other existing and planned MSS systems. The proposed Motient terrestrial implementation, as described by Motient in its application, would lead to levels of interference that would be so high as to reduce the MSS spectrum available to the MSS community as a whole for *satellite* service. Such an impact on the international MSS community, brought about by a terrestrial use within the US that contravenes the ITU table of frequency allocations, would violate the principles embedded in the ITU's Radio Regulations, and undermine the international allocation of the L band for MSS services.

In Section 2 of this Technical Annex we briefly summarize the various interference paths of concern that would arise from the proposed Motient terrestrial mobile system. In Section 3 we provide a detailed analysis of each of these interference paths, In Section 4 we provide the rationale for our technical assumptions used in these analyses. In Section 5 we comment on the inadequacies of the information provided by Motient concerning key technical parameters of their proposed terrestrial mobile network. Finally, in Section 6, we comment on the very dubious need for Motient to make use at all of the L-band MSS frequencies for its proposed terrestrial mobile system.

This Technical Annex takes into account our review of the original Motient FCC Application, the May 7 opposition of Motient, and the July 6 and July 25 ex parte submissions of Motient.[2,3,4,5]

1 *In the Matter of Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band, Notice of Proposed Rule Making,* IB Docket No. 01-185 and ET Docket No. 95-18 (rel. August 17, 2001) (the "*Flexibility NPRM*").

2 *Mobile Satellite Ventures Subsidiary LLC Application for Assignment and Modification of Licenses and for Authority to Launch and Operate a Next-Generation Mobile Satellite System, et al.,* File No. SAT-ASG-20010302-00017, et al. (filed March 1, 2001) (the "*Application*").

3 *Motient Consolidated Opposition to Petitions to Deny and Reply to Comments,* May 7, 2001.

4 *Motient Ex-Parte Presentation,* July 6, 2001 (filed July 6, 2001).

5 *Motient Ex-Parte Presentation,* July 24, 2001 (filed July 25, 2001).

2 Interference Paths

There are essentially two different interference paths with respect to MSS systems that would be created by the terrestrial service proposed by Motient:

1. The interference from the Motient terrestrial mobile transmitters to the MSS satellite receive beam. There are three different aspects to this interference path, as follows:
    a. Interference to other MSS satellites (such as Inmarsat) that are serving geographic areas outside of the USA (see Section 3.1 below);
    b. Interference to other MSS satellites (such as Inmarsat) that are serving the U.S. (see Section 3.2 below);
    c. Interference to the Motient MSS satellites in their beams serving areas of the US adjacent to the area where the co-frequency Motient mobile transmitters are operating (see Section 3.5 below).

2. The interference from the Motient base station transmitters to the MES (Mobile Earth Station) receivers of Inmarsat and other MSS systems operating in the geographic vicinity of the Motient base stations. This interference path gives rise to two different interference mechanisms:
    a. The overload of the MES receivers due to the presence of high power Motient base station signals in an immediately adjacent frequency band. This is a function of the linearity of the front end of the MES receivers. (See Section 3.3 below)
    b. The unwanted out-of-band signals from the Motient base station transmitters that fall directly in the receive band of the MES receivers. (See Section 3.4 below)

In addition, interference from both the Motient base station transmitters and the Motient terrestrial mobile transmitters would also exist with respect to other sensitive services operating in adjacent frequency bands, such as GPS.

3 Interference Analyses

In this section we will provide a realistic assessment of the interference on the various interference paths described in Section 2 above, taking account as much as possible of the ambiguities in Motient's explanation of its terrestrial system, which are addressed in Section 4.

3.1 Uplink Interference to Co-Frequency Inmarsat Satellite Beams Serving Geographic Areas Outside of the USA

This interference path is analogous to the already existing interference path from Motient MES transmitters to the Inmarsat satellite. In the existing case there is an obligation between MSS operators to accept a certain level of interference from each others' MSS operations. The level is either a 6% increase in the system noise temperature or an agreed upon level reached during coordination between the MSS operators. There is no obligation to accept, nor any capability to accommodate, any interference from *terrestrial* mobile transmitters at L-band.

In this case the Inmarsat satellite receivers will receive co-channel interference through the satellite antenna sidelobes from the Motient terrestrial mobile transmitters. It should be noted, however, that there are several factors where previous analyses submitted by Inmarsat and Motient differ, and these are discussed in Section 4. Taking into account the values for the parameters discussed in that Section, Table 3.1-1 gives a calculation of the interference from the Motient terrestrial mobile terminals (i.e., those transmitting to the Motient terrestrial base stations) into the Inmarsat-4 satellite.[6] The degradation to the Inmarsat satellite receive system noise temperature ("$\Delta T/T$") is calculated for a single Motient terrestrial mobile carrier.[7] Note that a single Motient terrestrial carrier anywhere on the surface of the visible Earth will degrade the Inmarsat satellite receive system noise temperature by 0.213%.

Note that some of the parameters that are used in this interference calculation are applicable to the interference situation when many Motient terminals are in operation – these are labeled as "average for many terminals" in Table 3.1-1. The reason for this is so that the results in Table 3.1-1 can be accurately scaled to the situation where there are multiple Motient terrestrial carriers in operation. This also implies of course that any single Motient terminal could produce interference levels in excess of that calculated in Table 3.1-1. The Motient mobile terminals will be distributed in various environments (indoors/outdoors, urban/suburban, etc). Hence, there will be some Motient terminals operating where the shielding is 0 dB and some Motient terminals where the power control factor is 0 dB. Based on the analysis in Table 3.1-1, one Motient carrier operating outdoors at full power would create around 0.7% increase in the Inmarsat satellite noise temperature. Thus, it would take fewer than nine such carriers to create an aggregate 6% noise increase. Alternatively, retaining the power control advantage assumed in Table 3.1-1, 14 Motient mobile carriers operating outdoors would create a 6% increase in the Inmarsat satellite noise temperature.

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6 This analysis relates to Inmarsat-4, as it is the most spectrum efficient MSS satellite in the Inmarsat system, and is typical of the MSS systems of the future.

7 Each Motient terrestrial carrier can support up to eight Motient terrestrial terminals, because of Motient's proposed use of GSM which is a TDMA system with up to eight users accessing each 200 kHz wide RF channel.

Table 3.1-1. Calculation of Uplink Interference from Motient Terrestrial Mobile Terminals to Co-Frequency Inmarsat-4 Satellite Beams Serving Geographic Areas Outside of the USA

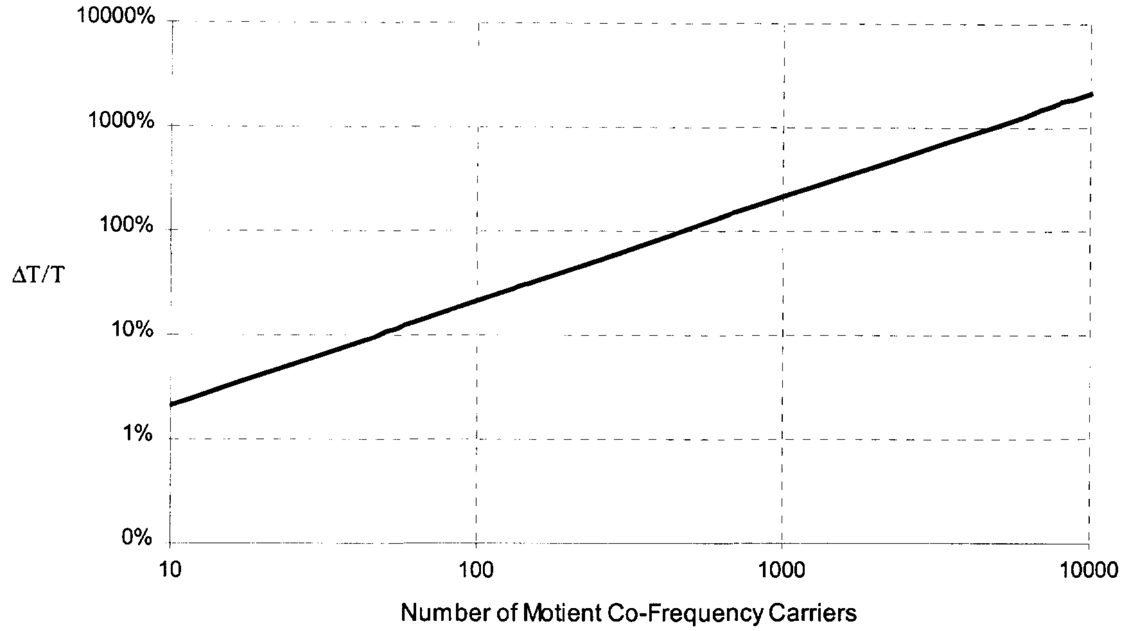
(a single Motient terrestrial carrier is assumed)

Parameter	Units	Value
Inmarsat Satellite G/T	dB/K	13
Inmarsat Satellite Antenna Gain	dBi	41
Inmarsat Satellite Receive Noise Temp	K	650
Inmarsat Satellite Receive Noise Spectral Density	dBW/Hz	-200.5
Motient Mobile Terminal EIRP	dBW/Hz	0
Motient Mobile Terminal Bandwidth	kHz	200
Motient Mobile Terminal EIRP Spectral Density	dBW/Hz	-53
Free Space Loss	dB	188.8
Shielding (average for many terminals)	dB	3
Inmarsat Satellite Receive Antenna Discrimination (average for many terminals)[8]	dB	20
Power Control Reduction (average for many terminals)	dB	2
Polarization Isolation (Linear-Circular) (average for many terminals)	dB	1.4
Received Interfering Signal Spectral Density	dBW/Hz	-227.2
ΔT/T increase per Motient carrier	%	0.213%

8 Note that the 20 dB discrimination value used in Table 3.1-1 is an average value over the Motient service area. In practice the antenna discrimination will vary depending primarily on the how close, in geographical terms, the co-frequency Inmarsat spot beam is to the Motient transmitting mobile terminal. Where the discrimination is lower the uplink interference will be higher and vice versa.

Figure 3.1-1 shows the aggregate effect when multiple Motient terrestrial mobile co-frequency carriers are in operation.

Figure 3.1-1. Increase in Receive System Noise Temperature of the Inmarsat-4 Satellite as a Function of the Number of Motient Terrestrial Mobile Co-Frequency Carriers



Note that, from Figure 3.1-1 it can be seen that the interference levels to the Inmarsat satellite can become unacceptably high with quite small numbers of co-frequency Motient carriers. With only 28 co-channel carriers there would be a 6% increase in Inmarsat's system noise temperature, and levels such as this would be unacceptable as it would degrade the overall performance of the Inmarsat system. It is clear, however, that Motient intends to operate many more than 28 co-channel carriers. In Motient's ex parte filing of 25 July 2001, Motient states that its terrestrial network will not exceed a co-channel frequency re-use of 9,000, but states that this limitation will apply only in certain L-band spectrum, and not in other L-band spectrum. Thus, there could be 9,000 co-frequency Motient carriers operating in some parts of the L-band and even more in other parts. With as few as 500 co-frequency Motient carriers, the increase in Inmarsat system noise temperature would be approximately 100%. At this level the Inmarsat link budget would be degraded by a full 3 dB. If indeed the number of co-frequency carriers increased to 9,000, then the increase in Inmarsat system noise temperature would be 1900%, in which case the interference level would be almost twenty times higher than the noise level. Both of these numbers (500 and 9,000) are well within the range assumed by Motient itself. As noted below in Section 5.3, however, it is reasonable to expect terrestrial usage by the Motient system to exceed these numbers of carriers.

There is no ITU mechanism for coordinating any terrestrial usage in this band because there are no terrestrial primary allocations in the ITU table of frequency allocations as given in Article S5 of the Radio Regulations. Thus, there is no standard for how any additional terrestrial interference should be taken into account. Any suggestion that the 6% ΔT/T interference allowance, reserved for satellite-to-satellite network coordination, could be available to the Motient terrestrial system is therefore baseless. Inmarsat's link budgets, according to long established ITU recommended criteria, include an allowance of 20% for all external interfering sources. In Inmarsat's case, all of this interference allowance is generally used up by adjacent MSS satellite networks with each satellite network being allocated 6% $\Delta T/T$. When the latest technology, multi-beam, MSS satellites are used (as is the case between Inmarsat 4 and the proposed next generation Motient satellite), the interference between the satellite networks (without taking account of the proposed Motient terrestrial system) may be higher because of the increased frequency re-use within the networks. Therefore there may be even less interference margin available for the most technically advanced spacecraft in the Inmarsat fleet. As the Commission is well aware, there are already great difficulties in coordinating L-band MSS operations in Region 2 and the addition of a new, terrestrial interference source will exacerbate the current coordination problems.

3.2 Uplink Interference to Adjacent-Frequency Inmarsat Satellite Beams Serving the USA

The Motient proposal gives rise to the possibility of large numbers of Motient mobile terminals operating in adjacent channels to those used for Inmarsat uplink beams in the USA. The aggregate effect of the out-of-band emissions from these Motient mobile terminals would produce unacceptable interference as shown below.

We note that Motient is particularly vague about the level of out-of-band emissions from its mobile transmitters that are communicating with the Motient terrestrial base stations. In the GPS/GLONASS frequency band (1559-1610 MHz) Motient proposes specific protection levels, but no such guarantees are provided for other parts of the MSS uplink frequency band below 1559 MHz which are not being used by Motient's satellite uplinks but rather by the satellite uplinks of other MSS systems such as Inmarsat.[9] In the absence of any specifically-proposed out-of-band emission constraint we can only assume that Motient intends to comply with nothing better than the general out-of-band emission limits contained in the 47 CFR § 24.238 and which is suggested in the Commission's NPRM on this matter.

For out-of-band emissions 47 CFR § 24.238 requires an attenuation of the signal (relative to the peak power of the transmitter) of 43+10log(P), where P is the peak power in Watts. Table 3.2-1 provides the analysis of this uplink interference for a single Motient terrestrial channel under this requirement. Note that the degradation to the Inmarsat satellite system noise temperature for a single Motient channel is quite small (approximately 0.001% $\Delta T/T$), but in the case of this interference the aggregate effect for multiple Motient channels must be obtained by multiplying this "single-terminal" number by the total number of Motient terrestrial channels that are used

9 Motient proposes to ensure that its base station transmitters comply with the requirement on out-of-band emissions that fall within the band 1559-1610 MHz to protect GPS/GLONASS, of less than –70 dBW/MHz with narrow-band transmissions less than –80 dBW/700Hz.

within the Inmarsat receive beam footprint.[10] At this stage we do not have sufficient information about the proposed Motient terrestrial system to be able to determine the likely or maximum number of such carriers. Considering, however, that a single Inmarsat receive spot beam could cover a geographic area as large as the north-east corridor from Washington DC to New York, then it is conceivable that there could be tens of thousands of Motient terrestrial channels simultaneously in use in such an area. In this case the additional degradation to the Inmarsat satellite noise temperature would be in excess of 10%, and therefore totally unacceptable.

Table 3.2-1. Calculation of Uplink Interference from Motient Terrestrial Mobile Terminals to Adjacent-Frequency Inmarsat-4 Satellite Beams Serving the USA

(a single Motient terrestrial carrier is assumed)

Parameter	Units	Value
Inmarsat Satellite G/T	dB/K	13
Inmarsat Satellite Antenna Gain	dBi	41
Inmarsat Satellite Receive Noise Temp	K	650
Inmarsat Satellite Receive Noise Spectral Density	dBW/Hz	-200.5
Motient MES Transmit Power to Antenna per 200 kHz Carrier	dBW	0.0
Motient MES Transmit Power to Antenna per 200 kHz Carrier	W	1.0
Motient MES Transmit Antenna Gain	dBi	0.0
Motient MES Transmit EIRP per 200 kHz Carrier (in Motient channel)	dBW	0.0
Out-of-Band Attenuation (43+10log(P))	dB	43.0
Motient MES Transmit EIRP per 200 kHz Carrier (in Inmarsat channel)	dBW	-43.0
Motient MES Transmit EIRP Spectral Density (in Inmarsat channel)	dBW	-96.0
Free Space Loss	dB	188.8
Shielding (average for many terminals)	dB	3
Power Control Reduction (average for many terminals)	dB	2
Polarization Isolation (Linear-Circular) (average for many terminals)	dB	1.4
Received Interfering Signal Spectral Density	dBW/Hz	-250.2
$\Delta T/T$ increase per Motient terrestrial carrier	%	0.001067%

10 Note that this calculation differs from that given in Section 3.1 above where the multiplying factor is the number of co-frequency channels in use in the proposed Motient terrestrial system across the entire visible Earth.

3.3 Interference to Inmarsat MES Receivers Due to Overload from the Adjacent-Channel Transmissions of the Motient Base Station Transmitters

In this section we will consider the interference resulting from overload of the Inmarsat MES receivers by the adjacent channel signals transmitted by the proposed Motient base station transmitters.

As an initial matter, the Inmarsat MES receivers have been designed to operate in an RF environment that is defined in many essential aspects by the ITU table of frequency allocations that are contained in Article S5 of the Radio Regulations. Table 3.3-1 provides an extract of these ITU frequency allocations for the majority of the L-band used by Inmarsat.

Table 3.3-1. Extract from the ITU Tables of Frequency Allocations (Article S5 of the ITU Radio Regulations)
Relating to the L-Band MSS Downlink Frequency Band

1 535-1 559	MOBILE-SATELLITE (space-to-Earth) S5.351A S5.341 S5.351 S5.353A S5.354 S5.355 S5.356 S5.357 S5.357A S5.359 S5.362A

Note that the entire downlink allocation from 1535-1559 MHz is reserved for MSS (Mobile-Satellite Service), and there are no significant primary allocations anywhere in the world to the terrestrial fixed or mobile services, or to any other service that might employ Earth-based transmitters.[11]

Thus, there is no reason for MSS receivers operating in this band to be designed to work in the presence of anything other than satellite-transmitted signals. If they were to be subjected to high-power terrestrially transmitted signals that are outside of their intended receive bandwidth but in the adjacent frequency bands, they are likely to be "overloaded", which means they will suffer a reduction in sensitivity or fail to operate at all, depending on the level of the interfering signal. For this reason, the Inmarsat MES receivers already in operation are not designed to reject this type of terrestrial interference, and in fact the Inmarsat specification for its receivers contains no explicit reference to the threshold level for overload to occur.

3.3.1 Interference to Land or Marine-Based Inmarsat Receivers

In the case of the Inmarsat Mini-M terminal, which is the best selling "satellite phone" in the Inmarsat system, and which is approximately the size of a laptop PC, the only reference to the level of allowable high power signals which is acceptable is that it must be able to tolerate an aggregate incident PFD (Power Flux Density) of −105 dBW/m^2 in the direction of the Inmarsat satellites. Assuming an antenna gain of +10 dBi for the Mini-M receive antenna, this is equivalent to a received signal level of -120 dBW at the output of the antenna. Although it is

[11] Footnote S5.355 of the Radio Regulations provides for a secondary allocation to the Fixed Service in a 5.5 MHz portion of this band and only in certain African and Middle-Eastern countries. Footnote S5.359 provides for a primary allocation in part of this band in certain European, African and Middle Eastern countries, but deployment of such systems is very limited.

possible that the Inmarsat receivers can in practice tolerate somewhat higher adjacent band interfering signals without overload occurring, performance in this respect is not specified or guaranteed by the manufacturer.

Table 3.3-2 provides an analysis of the interfering signal level that would be received by the Inmarsat MES receiver from the Motient base station transmitter (BST) in the immediately adjacent frequency band and which could cause overload to occur. The analysis uses an EIRP per 200 kHz carrier of 19.1 dBW, as provided in Motient's application.[12] In the absence of any specific information from Motient, the analysis assumes that the Motient base station will be transmitting in a total of 5 MHz of spectrum (i.e., 25 x 200 kHz channels), which may be conservative in terms of the number of channels. The calculation shown assumes that the Inmarsat receiver is located 100 meters from the Motient base station and that a clear line-of-sight exists between them (i.e., "shielding" value of 0 dB). This scenario would seem quite likely considering Motient's assertion that the base station transmitters will be located on the top of buildings and towers. For the sake of example, we use the values of 6 dB and 4 dB for the "power control reduction" and "voice activity reduction", respectively, as proposed by Motient, although we have seen no evidence that these reductions will exist in practice. For the polarization isolation (LHCP into RHCP)[13] we use a value of 3 dB, which we believe is appropriate in a multi-path environment and for directions well away from the main beam of the Inmarsat receive antenna. We do not agree with the value that Motient uses for this parameter, which is 8 dB, and for which there is no justification at all provided by Motient. The Inmarsat receiver is assumed to have a gain of 0 dBi towards the interfering base station transmitter, which is quite conservative and the gain could actually be higher than this.[14]

The result of this analysis is that the interfering Motient signal is 64.1 dB higher than the threshold overload factor that Inmarsat can be certain of at this stage (see previous paragraph). This corresponds to an interfering signal that is almost *4 million times higher* than it should be for this scenario.

12 Motient FCC Application, Appendix A (System Design), Table 2-1 on page 30.

13 Note that Motient proposed to use Linear Vertical Polarization for its base station transmissions in its FCC Application but later changed this in its subsequent FCC filings to Left Hand Circular Polarization (LHCP), presumably in an attempt to ameliorate the serious interference problems.

14 The Inmarsat Mini-M terminal's antenna has a 60° half-power beamwidth and the 0 dBi point occurs 65° off axis.

Table 3.3-2. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End

Parameter	Units	Value
Motient Base Station EIRP per 200 kHz Carrier	dBW	19.1
Total Bandwidth of Motient Base Station Transmissions	MHz	5
Number of Motient Base Station Carriers per Cell (each 200 kHz)	#	25
Distance of Inmarsat MES Terminal from Motient Base Station Transmitter	m	100
Free Space Loss (Line-of-Sight)	dB	76.0
Shielding	dB	0
Power Control Reduction	dB	6
Voice Activity Reduction	dB	4
Polarization Isolation (LHCP-to-RHCP in a multi-path environment)	dB	3.0
Gain of Inmarsat MES Terminal towards Motient Base Station Transmitter	dBi	0.0
Received Interfering Signal Power	dBW	-55.9
Threshold for Overload of Inmarsat MES Terminal	dBW	-120.0
Margin	dB	-64.1

The results in Table 3.3-2 can be easily extrapolated to different scenarios of the physical separation between the Motient base station transmitter and the Inmarsat receiver, assuming that a line-of-sight between the two still exists. In this case a ten times increase in the distance would reduce the interference by 20 dB. Therefore at 1,000 meters separation the excess interference in Table 3.3-2 would reduce to 44.1 dB, and at 10,000 meters separation it would reduce to 24.1 dB, and so on. In these cases, the interfering signal is still more than 25,000 times and 250 times, respectively, higher than it should be. Of course, if the Inmarsat receiver is on the ground, and the Motient base station transmitter is located in an urban environment, then the line-of-sight propagation assumption would not be valid for distances in excess of 1,000 meters or so. However, in the case of an airborne Inmarsat receiver the line-of-sight assumption remains perfectly valid, and overload could occur, even at very large distances. This matter is addressed later in Section 3.3.2 below.

Under any line-of-sight circumstance, the main conclusion of this analysis remains valid: based on the current specification of the Inmarsat receivers, serious overload will occur even for large physical separations of the Inmarsat receiver from the Motient base station transmitter.

Motient has a different assessment of this interference potential.[15] Motient claims to have measured the actual overload performance of "several satellite terminals from a variety of manufacturers" and concluded that the relevant threshold value should be –88 dBW (at the antenna output) for greater than 400 kHz separation, as compared to the value of –120 dBW presented above. Inmarsat has no reason to believe that such a value of –88 dBW accurately represents the performance of the Inmarsat terminals that are deployed today and currently being manufactured, and Motient has not provided any back-up data at all for their claim concerning the overload performance. However, even if the overload threshold performance actually were –88 dBW, the excess interference in Table 3.3-2 would still be 32.1 dB, and the physical separation would have to be approximately 4,000 meters to reduce this excess to zero, under line-of-sight conditions. It would appear from this that, if the Motient terrestrial system is

15 Motient Consolidated Opposition to Petitions to Deny and Reply to Comments, 7 May 2001.

implemented, urban (and probably suburban) areas would effectively become "no-go" zones for Inmarsat receivers, and Inmarsat's service would be relegated to a one that could reliably serve only rural areas. Inmarsat therefore would lose its ability to provide ubiquitous service due to Motient's nonconforming terrestrial service.

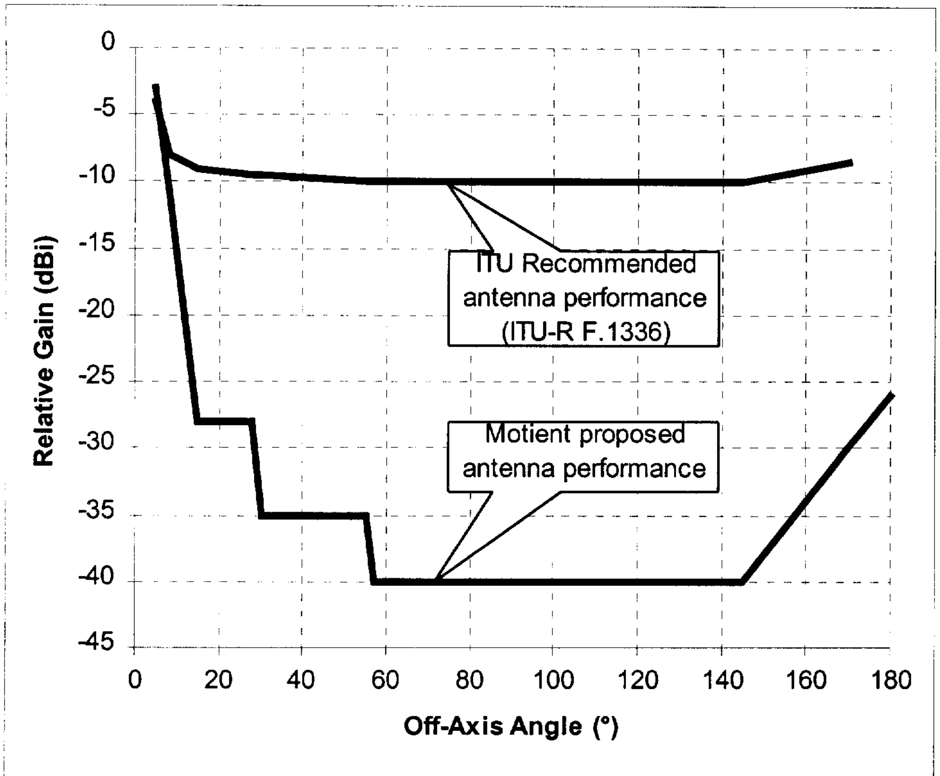
3.3.2 Interference into Airborne Inmarsat receivers

Interference to airborne Inmarsat receivers is of crucial concern for public safety reasons. Motient's analysis of this interference asserts that, provided they use their "specially designed antenna"[16], and provided they take special measures in the vicinity of airports, there should be no problem. The following analysis refutes this assertion based on the following:

- The base station transmit antenna proposed by Motient appears to have a level of performance that is unrealistically high. Figure 3.3-1 compares the performance claimed by Motient with the ITU recommended antenna gain mask for a 1.5 GHz point-multipoint base station antenna, as given in ITU-R Recommendation F.1336. Note that there is ample evidence in the technical papers of the ITU Working Parties that this antenna mask accurately represents base station antennas of this type. The surprising result is that the antenna proposed to be used by Motient exceeds the ITU Recommendation by 30 dB for large ranges of off-axis angles, and this directly impacts the interference that will be caused to airborne Inmarsat receivers. Motient does not substantiate its ability to obtain antennas that outperform the ITU standard to this extent, and Inmarsat questions whether such performance could be economically and reliably obtained.

[16] Motient FCC Application, Appendix A (System Design), pages 27-29.

Figure 3.3-1. Comparison of the Motient Proposed Base Station Antenna Performance with the ITU Recommended Performance



- Motient's analysis appears to assume that there will be only one Motient 200 kHz carrier from a single Motient base station transmitter causing interference to an aircraft in flight. In fact, as shown in the analysis below, when multiple Motient carriers are taken into account the required separation distances are significantly greater and the additional possibility exists of interference *from a number of separate Motient base station transmitters* which further increases the required separation distances.

- Motient's analysis assumes that the overload threshold level for the Inmarsat receivers is –88 dBW at the antenna output. As explained above, there is no technical data provided to support Motient's claim that these receivers actually perform at this level in the face of terrestrial interference that they were not designed to reject, and Inmarsat believes the actual overload level is significantly lower than this.

Inmarsat has performed its own initial analysis of the "safe flight path boundary" for aircraft in the vicinity of a Motient base station transmitter. Table 3.3-3 provides the details of the analysis which is essentially the same as that described in Section 3.3.1 above for the terrestrially based Inmarsat receiver, and the same assumptions are used for all the parameters as in that analysis. The difference is that the gain characteristic of the Motient base station transmit antenna is taken into account, in order to calculate the interference for a range of elevation angles (not just horizontal). In the first set of results given below in Figure 3.3-2, the proposed Motient base station antenna mask is used, and the overload threshold is assumed to be –120 dBW at the

Inmarsat receive antenna output. Note that all the results presented below are for a single Motient base station interferor and, as stated above, this may not be appropriate, and the effect of multiple Motient base station transmitters should be taken into account. The results also assume a –5° tilt angle for the Motient base station transmit antenna, unless otherwise stated and assume in all cases that the Motient base station antenna is 30 meters above the ground.

Figure 3.3-2. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Aircraft altitudes above which overload will not occur

Motient BTS Antenna Mask; -120 dBW Overload Threshold; Tilt Angle –5°
(data given in Table 3.3-3)